OBSERVATIONS ON *MICROPHALLUS OVATUS* SP. NOV. FROM THE CRAYFISH AND BLACK BASS OF LAKE CHAUTAUQUA, N. Y.*

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The recent account by Yoshida (1916: 76-82) of an unnamed trematode infesting the liver, ovary and other tissues of Japanese crustacean, living in burrows between tides on the seashore near Osaka, recalls some observations which I made several years ago, but which have never as yet been published. Though Yoshida did not designate the form which he described, his account and drawings show it to be a member of the genus Microphallus (Ward, 1901: 184). For convenience, I will refer to it as *M. japonicus,* which name I would propose to call it.

Especial interest attaches to the case of *M. japonicus* as another instance of that remarkable correspondence between parasite and host organ infected which has been noticed by various writers and in particular by Johnston (1913: 272) in Australian frogs. *M. japonicus* is the third case now known where the liver or adjoining thoracic viscera of the crayfish or some other crustacean is infected by a species of Microphallus.

I first noticed the Chautauqua species in the crayfish in the summer of 1898 and saw its close relationship with *M. opacus* of Ward (1894: 173 and 1901: 175). I found it later also in the stomach of the black bass and of the bullhead from Lake Chautauqua. In the liver of the crayfish (Fig. 1) it forms large whitish spherical cysts among the tubular cecae of the infected organ. In August, 1902, it was found in every individual of a group of twenty-five examined. In one instance 22 cysts were found on one side and 18 on the other, totalling 40 cysts for the organ. One case, very badly infected, showed about 100 cysts. In the stomach of the black bass partly digested crayfish are often found, and specimens of the worm in various stages are seen which are thus traced to the crayfish as the source of infection. The bass is more often infected than the bullhead, the diet of the latter regularly being more largely molluscan. The Chautauquan form shows marked resemblances to *M. opacus,* but there are certain differences which seem at present to justify distinguishing them and I am proposing to give it the name *M. ovatus* in allusion to its shape.

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M. ovatus differs from *M. opacus* in its habits, the latter infecting not the liver but the genital glands and the space above the cephalothorax. The Japanese species infects the liver like *M. ovatus,* and also the ovary like *M. opacus.* The final host of *M. opacus* also is different. Ward examined *Micropterus dolomieu,* "yet none were infected"; though it was found in the yellow perch, but the chief host is *Amia calva,* where hundreds were found in the intestine (vs. stomach in *M. ovatus*) just above the spiral valve.

The cysts of *M. ovatus* as removed from the liver are slightly elongate, measuring 1 mm. by 0.7, slightly smaller than Ward's figures, 1.28 mm. by 0.9, and larger than *M. japonicus,* which averages 0.521 mm. by 0.418. The encysted worm is bent double ventrally; under slight compression enough of its structure is visible to show that it is nearly or completely developed, as shown in Figure 2, drawn from a specimen immediately after its escape from the cyst. Inside the cyst the anterior end of the body can be seen actively moving. The crustacean host is thus evidently an intermediate host interpolated between the primary host and the definitive one, as happens in the case of Clinostomum and various other genera of trematodes.

Specimens of the free mature worm from the bass (Fig. 3) had the body densely packed posteriorly with the genital glands, but clear anteriorly so that this part was very mobile, pushing itself forward and seeming to adhere slightly by means of the small oral sucker, while a wave of contraction swept backward the whole length of the body giving it a dumb-bell shape as it passed the center and passed off over the hind end without influencing its form. *M. ovatus* is larger than *M. opacus* and presumably than *M. japonicus,* the adult of which is not known. The dimensions of the body in a mature specimen from the bass were 2.6 by 1.7 mm. Another worm drawn under slight compression measured 3.7 by 1.2 mm. One from the bullhead gave 3 by 1.8 mm. Ward gives 1.7 by 1 mm. for *M. opacus,* and *M. japonicus* from the crustacean cysts in maximum specimens was 0.833 by 0.325 mm. As the organization of the encysted specimens of *M. japonicus* is almost completely developed, one must conclude that the mature worms are much smaller than the American forms. The cuticula is spinous throughout as in the Japanese form, but unlike the *M. opacus* according to Ward, who says (1894) that the entire surface is free from spines.

The terminal oral sucker measured 0.125 mm. in a section of the worm, in another case drawn from a living specimen it measured 0.1 mm. Ward gives 0.155 in *M. opacus,* and Yoshida 0.05 mm. In the size of the ventral sucker, *M. ovatus* also differs from the others,

measuring 0.16 and 0.175 mm. in two cases, as against 0.210 in *M. opacus* and 0.035 in *M. japonicus*. The suckers are relatively larger in *M. opacus* as the bodies are smaller. In *M. ovatus* the ventral sucker is located on the level of the fifth eighth of the body length. It is located at about the same point in *M. opacus,* but in *M. japonicus* it is more posterior, being placed at the sixth eighth of the total length. The genital opening is located on the level of the center of the ventral sucker and in immediate contact with its left side. The excretory opening is placed at the extreme posterior end of the body.

The digestive apparatus is very poorly developed, the least of any of the members of this family. The very feebly developed pharynx, slightly more remote from the oral sucker than is that of *M. opacus,* has a length of less than 0.1 mm. and a diameter of only 0.05 mm. A long, slender esophagus leads back to a small triangular sack which can hardly be said to be forked, thus contrasting with the distinctly developed ceca of *M. opacus* and the still more elongate ones of *M. japonicus*. Sections and total preparations show a feebly developed epithelium in the interior of this digestive apparatus, but no conspicuous glands connected with esophagus.

The dorsally located excretory bladder is V-shaped, each side is broad and conspicuous, measuring about 0.4 mm. in length and having a diameter of about 0.1 mm. In specimens from the crayfish the cavities of these vesicles are filled with highly refractive globules doubtless the stored excretions resulting from the metabolisms of the encysted animal, similar to those found in various other cases of encysted stages (e. g. Faust, 1917: 42), but not found in the mature worms from fishes.

Possibly the drawings of Yoshida (Fig. 2) may be interpreted to mean the same thing. The excretory vesicles of living specimens were watched on several different occasions, but no pulsations or other movements were detected. A slender tube was traced forward from each horn of the bladder to a point on the level of the pharynx. These lateral vessels gave rise to smaller vessels which in turn gave rise to capillaries and terminated in flame cells. As in *M. opacus* and *M. japonicus* the cerebral ganglion and the lateral nerve cords are very noticeable even in preserved preparations.

All of the reproductive organs are confined to the posterior half of the body. The compact globular testes lie nearly opposite each other, they are distinct and not in contact with the excretory vesicles, whereas in *M. japonicus* they are apparently in contact. Their ducts join and form a common duct which, passing anteriorly to the ventral sucker, enters the posterior side of the large seminal vesicle which

lies directly in front of the ventral sucker. The organ is also conspicuous in *M. japonicus,* where it is called by Yoshida "the semilunar organ." In mature specimens it was filled with living spermatozoa. It tapers distally (see Fig. 5) to form a passage leading directly to the eversible penis and surrounded by cells of the prostate glands. As in all the Microphallinae, these parts are not enclosed in a cirrus sack after the manner of many trematodes. There is no atrial pocket common to the penis and metraterm as in Levinseniella (Lühe, 1899: 124), but these organs reach the surface entirely separately, as shown in Figure 4. The globular ovary, larger than the testes, lies on the level of the ventral sucker and on the right side of the body. Its duct meets the vitelline ducts close behind the ventral sucker as in *M. opacus,* there is no seminal receptacle, the uterus in mature stages is much enlarged and filled with eggs, in encysted stages from the crayfish its empty windings can be seen. The course of the uterus in a mature specimen is shown in Figure 3. After leaving the yolk receptacle it runs to the posterior end of the body, then bending, runs forward and back again on that side externally to and partly enclosing the vitellaria it then crosses to the opposite side and again runs forward and back in close relation with the vitellarium; finally it runs directly forward to the genital opening. The uterus contains great numbers of small dark-shelled operculated ova which measure 25 by 12μ, slightly smaller than those of *M. opacus,* which, according to Ward, measure 0.03 to 0.04 by 0.015 to 0.02 mm.

The vitellaria are more compact apparently than in *M. japonicus,* where the follicles are shown as if quite distinct and apparently are less deeply lobed than in *M. opacus.* They are located externally to the spermaries and extend beyond them reaching as far anterior as the level of the ventral sucker. Their position is intermediate between that of the *M. opacus* and *M. japonicus,* where they are wholly behind the spermaries or wholly anterior to them, respectively.

The habits of *M. ovatus* are slightly different from those of *M. opacus.* From the accounts of Ward one would consider that the liver of the crayfish is not infected, as the infection is said to be seated in the space above the cephalothorax and sexual organs. The final host also is different as shown by Ward who examined *Micropterus dolomieu,* "yet none were infected," though it was found in the yellow perch, but it is found in *Amia calva* where hundreds were found in the intestine just above the spiral valve. We note also that the Japanese species inhabit the liver of its crustacean host like *M. ovatus* as well as the "ovary and hypodermis" like *M. opaca.*

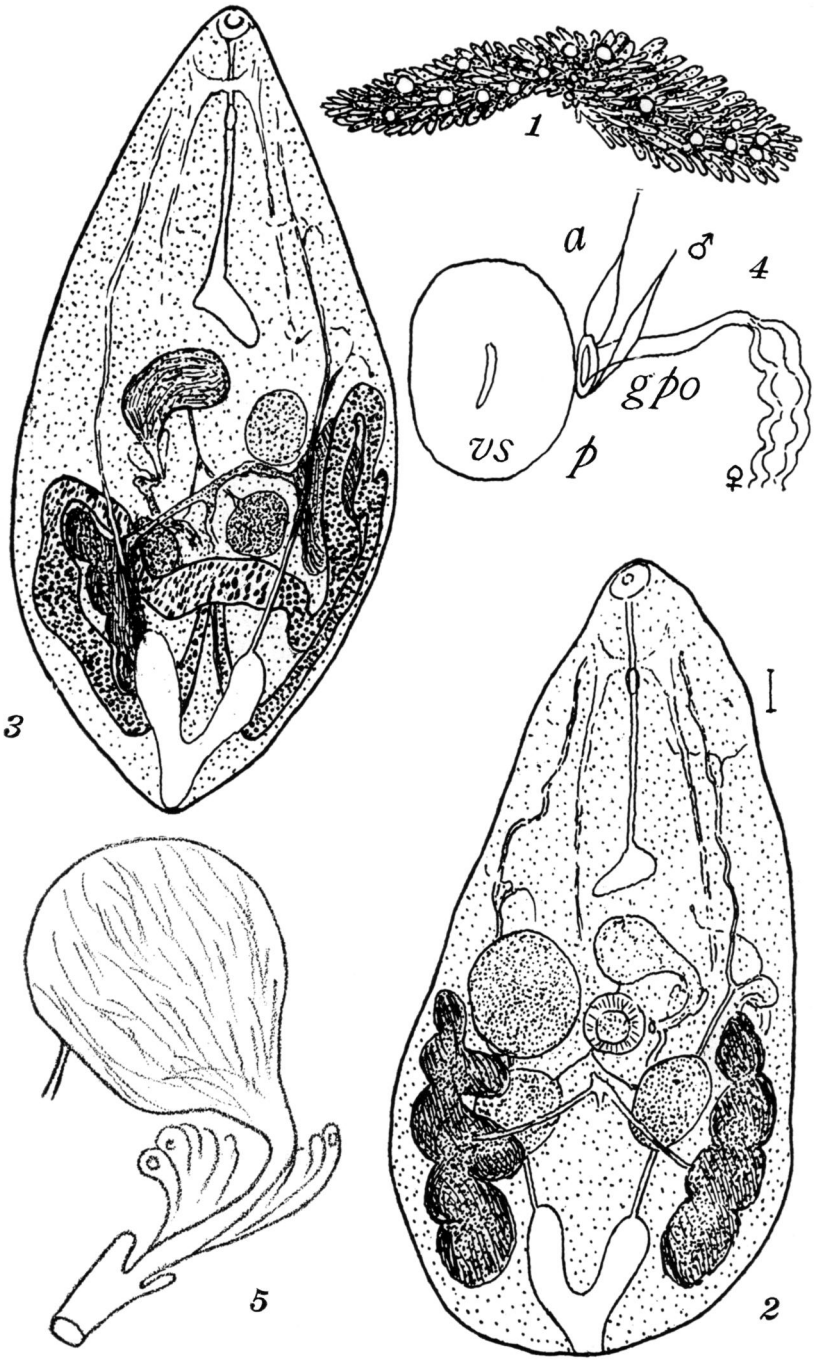

PLATE X

The differences noted between these three species are shown briefly in the following table.

Microphallus	*Opacus* Ward	*Japonicus* Yoshida	*Ovatus* Osborn
Infect as larva	Genital glands, cephalothorax of Cambarus	Liver, ovary and cephalothorax of Helice	Liver, of Cambarus
Adult	Intestine of Amia	.....	Stomach of bass
Maximum length	1.7 mm.	0.85 mm.	3.7 mm.
Cuticula	Non-spinous	Spinous	Spinous
Ventral sucker	0.210 mm.	.....	0.175
Intestinal ceca	Distinctly formed	Moderately long	Very rudimentary
Vitellaria	Deeply lobed, wholly posterior to testes	Wholly divided; wholly anterior	Slightly lobed, enveloping testes

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Exlanation of Plate

Fig. 1.—View of the liver of Cambarus from Lake Chautauqua, N. Y., showing the cysts of *M. ovatus* in place among the tubules of the organ.

Fig. 2.—Ventral view of immature specimen of *M. ovatus* immediately after its escape from the cyst, based on camera lucida drawings from compressed living specimens and total preparations. Scale equals 0.1 mm.

Fig. 3.—Dorsal view of mature specimen, taken from the stomach of *Micropterus dolomieu*, showing the location of the coils of the uterus well filled with embryos, from free hand drawings.

Fig. 4.—View showing the relation of the ventral sucker, genital opening, penis and metraterm; drawn from living compressed specimen.

Fig. 5.—View from living specimen showing form of the seminal vesicle, prostate glands and eversible penis.